Hole's Human Anatomy and Physiology

Twelfth Edition

Shier ◆ Butler ◆ Lewis

Chapter 9 Muscular System

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9.1: Introduction

Three (3) Types of Muscle Tissues

- Skeletal Muscle
  - Usually attached to bones
  - Under conscious control
  - Somatic
  - Striated
- Cardiac Muscle
  - Wall of heart
  - Not under conscious control
  - Autonomic
  - Striated
- Smooth Muscle
  - Walls of most viscera, blood vessels and skin
  - Not under conscious control
  - Autonomic
  - Not striated

9.2: Structure of Skeletal Muscle

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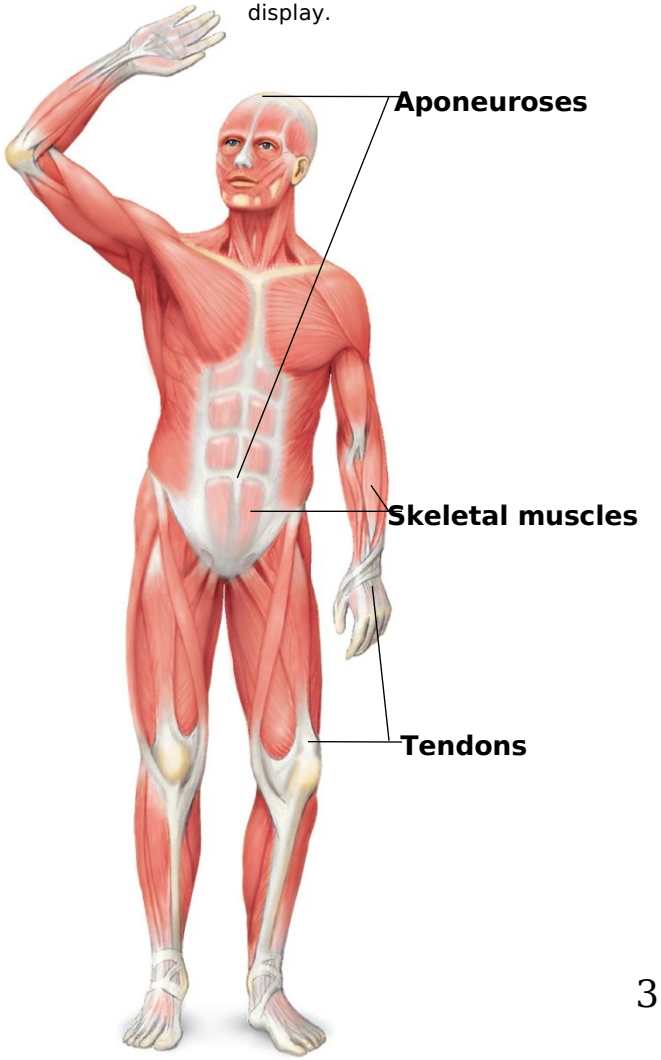
- Skeletal Muscle
  - Organ of the muscular system
    - Skeletal muscle tissue
    - Nervous tissue
    - Blood
    - Connective tissues
  - Fascia
  - Tendons
  - Aponeuroses



Connective Tissue Coverings

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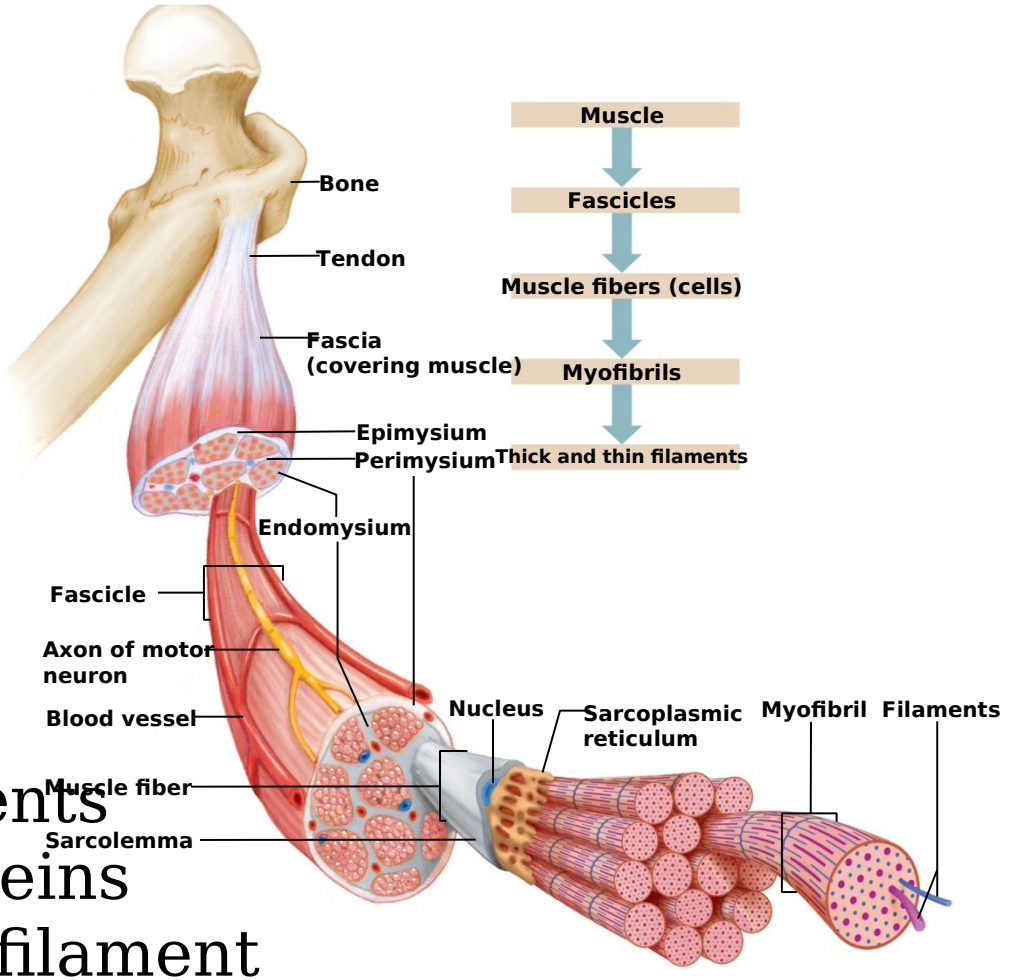
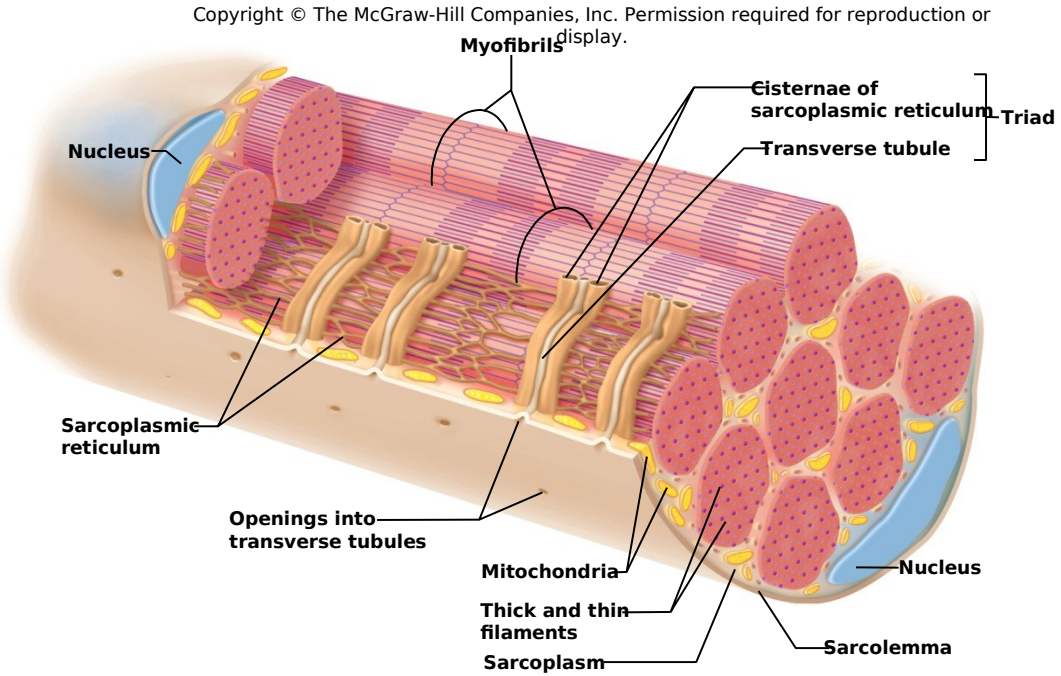
- Muscle coverings:
  - Epimysium
  - Perimysium
  - Endomysium

- Muscle organ
- Fascicles
- Muscle cells or fibers
- Myofibrils
- Thick and thin myofilaments
  - Actin and myosin proteins
  - Titin is an elastic myofilament



Skeletal Muscle Fibers

- Sarcolemma
- Sacroplasm
- Sarcoplasmic reticulum (SR)
- Transverse (‘T’) tubule
- Triad
  - Cisternae of SR
  - T tubule
- Myofibril
- Actin myofilaments
- Myosin myofilaments
- Sarcomere



9.3: Skeletal Muscle Contraction

- Movement within the myofilaments
- I band (thin)
- A band (thick and thin)
- H zone (thick)
- Z line (or disc)
- M line

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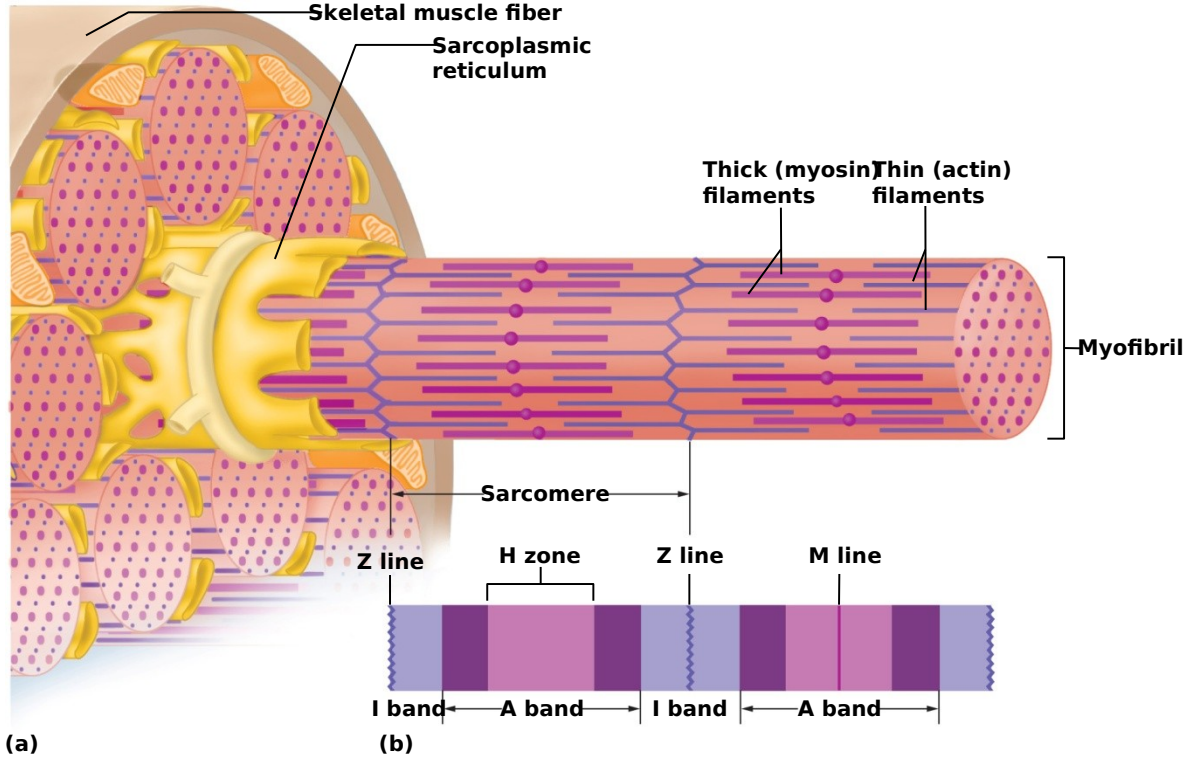

Myofilaments

- Thick myofilaments
  - Composed of myosin protein
  - Form the cross-bridges
- Thin myofilaments
  - Composed of actin protein
  - Associated with troponin and tropomyosin proteins

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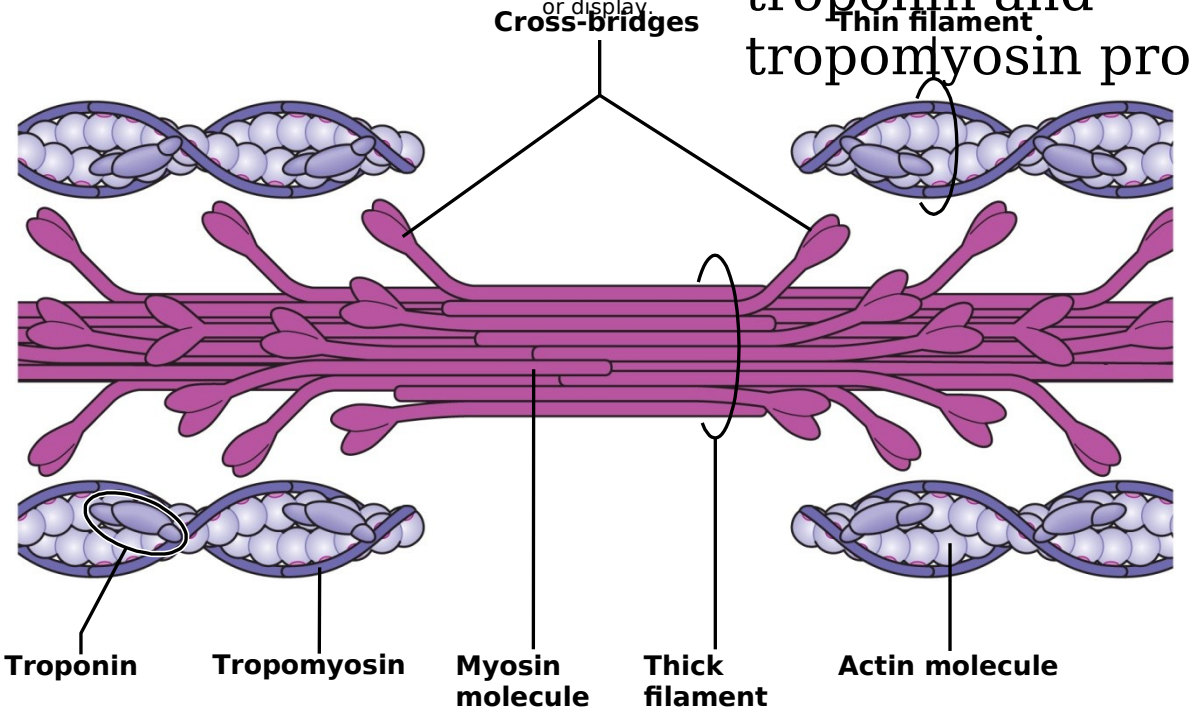

Neuromuscular Junction

- Also known as NMJ or myoneural junctio
- Site where an axon and muscle fiber mee
- Parts to know:
  - Motor neuron
  - Motor end plate
  - Synapse
  - Synaptic cleft
  - Synaptic vesicle
  - Neurotransmitte

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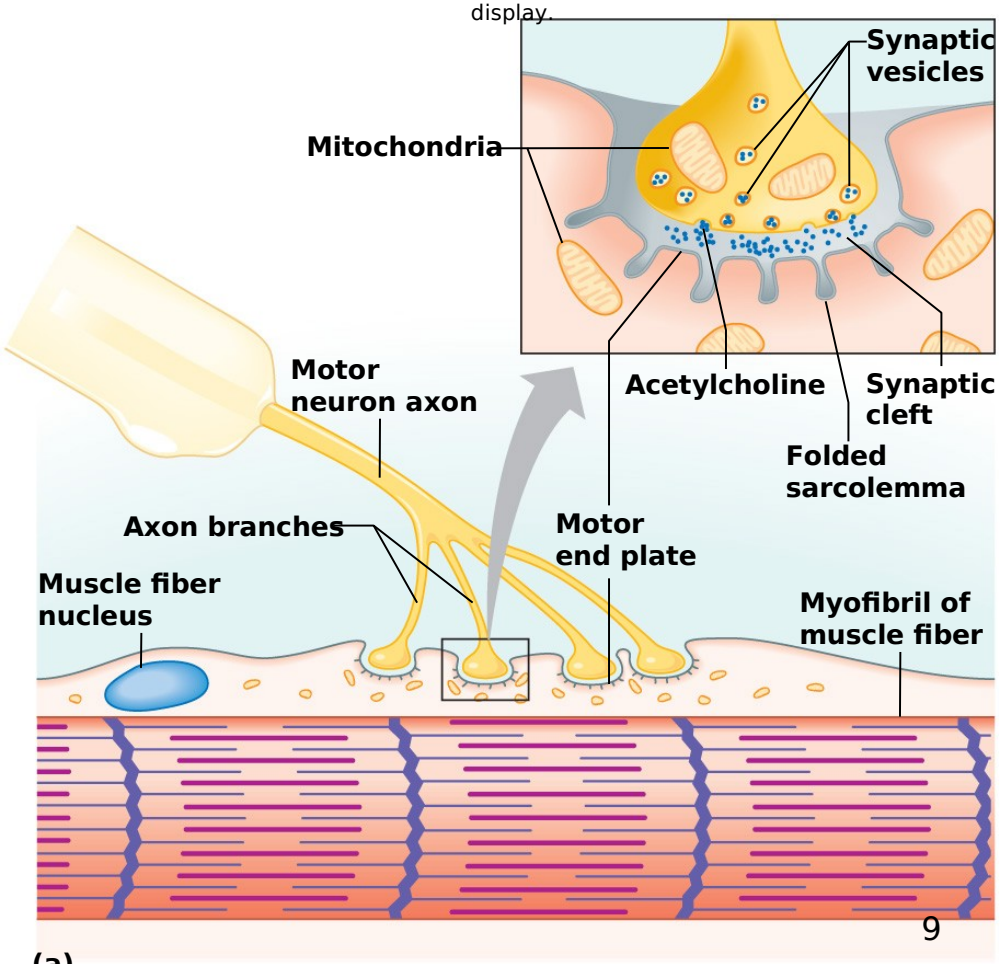
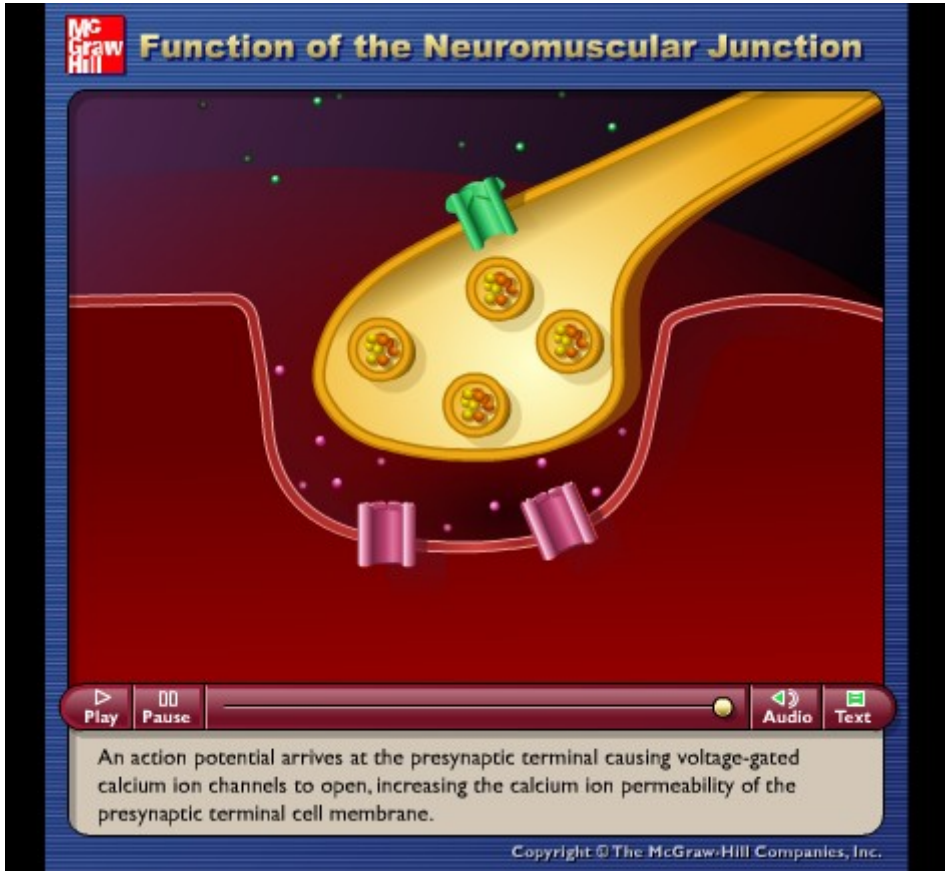


Animation: Function of the Neuromuscular Junction


Function of the Neuromuscular Junction
Play
Pause
Audio
Text
An action potential arrives at the presynaptic terminal causing voltage-gated calcium ion channels to open, increasing the calcium ion permeability of the presynaptic terminal cell membrane.
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Motor Unit

- Single motor neuron
- All muscle fibers controlled by motor neuron
- As few as four fibers
- As many as 1000's of muscle fibers

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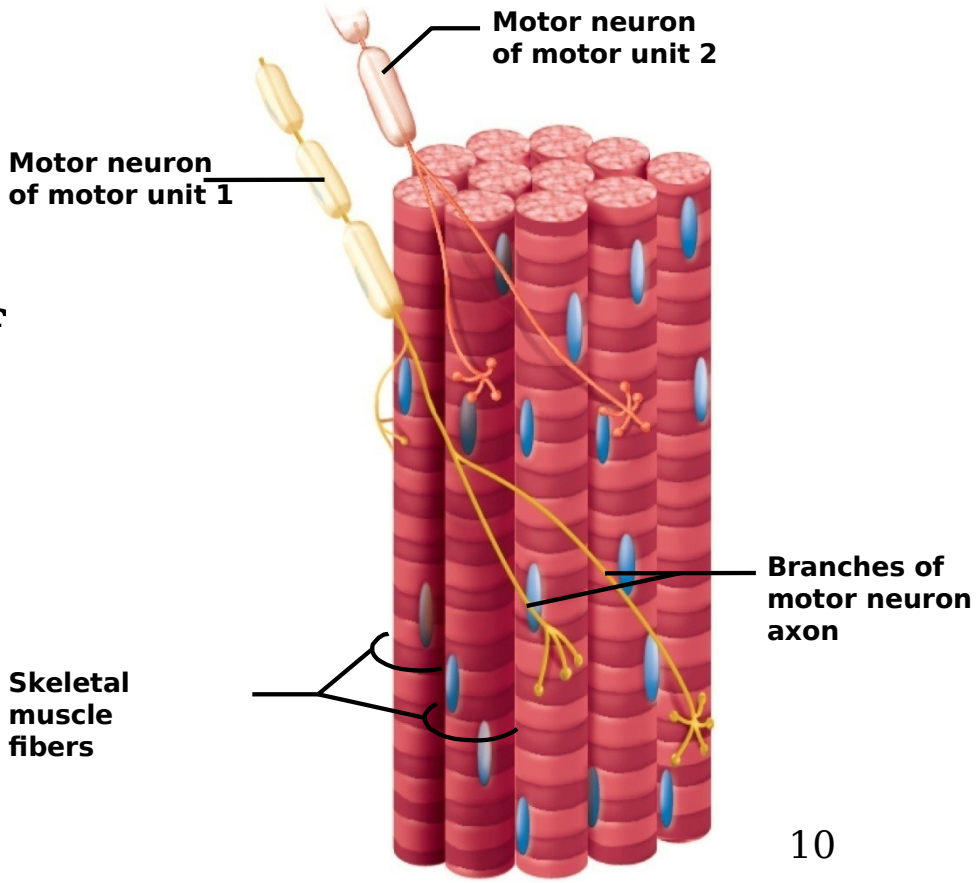

Stimulus for Contraction

- Acetylcholine (ACh)
- Nerve impulse causes release of ACh from synaptic vesicles
- ACh binds to ACh receptors on motor end plate
- Generates a muscle impulse
- Muscle impulse eventually reaches the S and the cisternae

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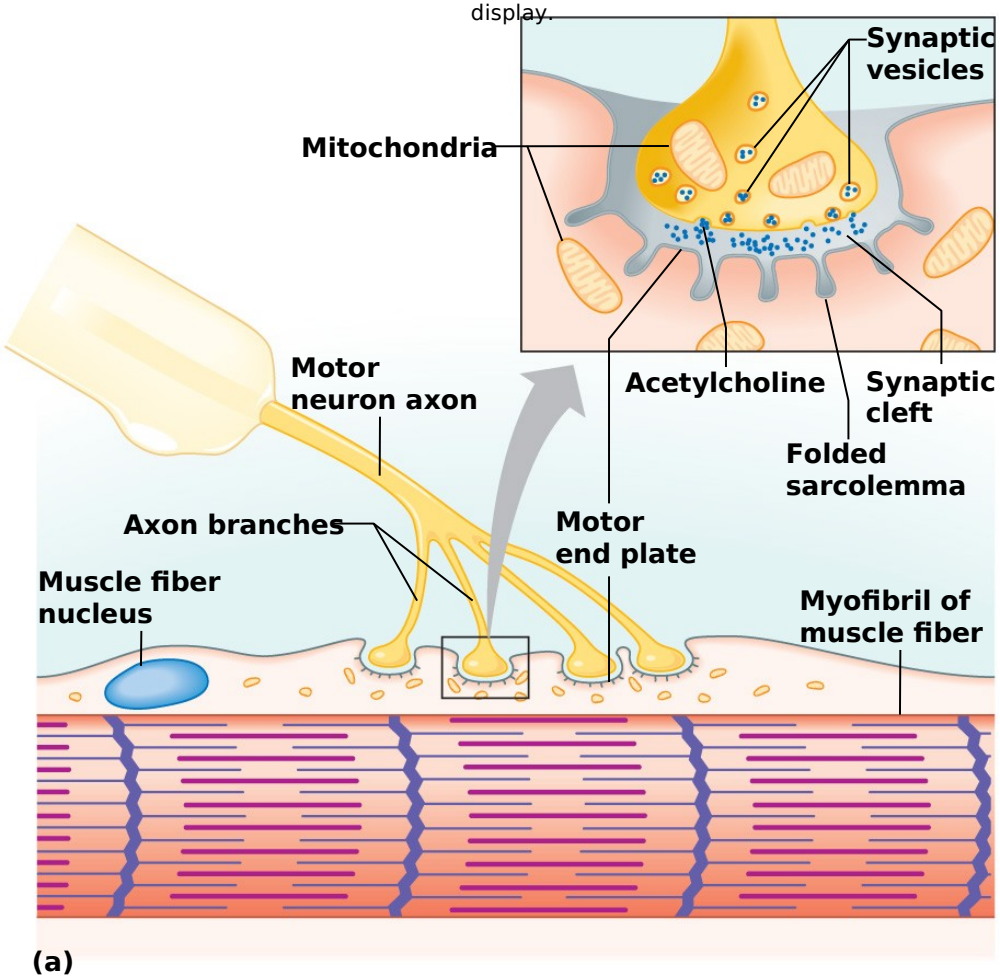
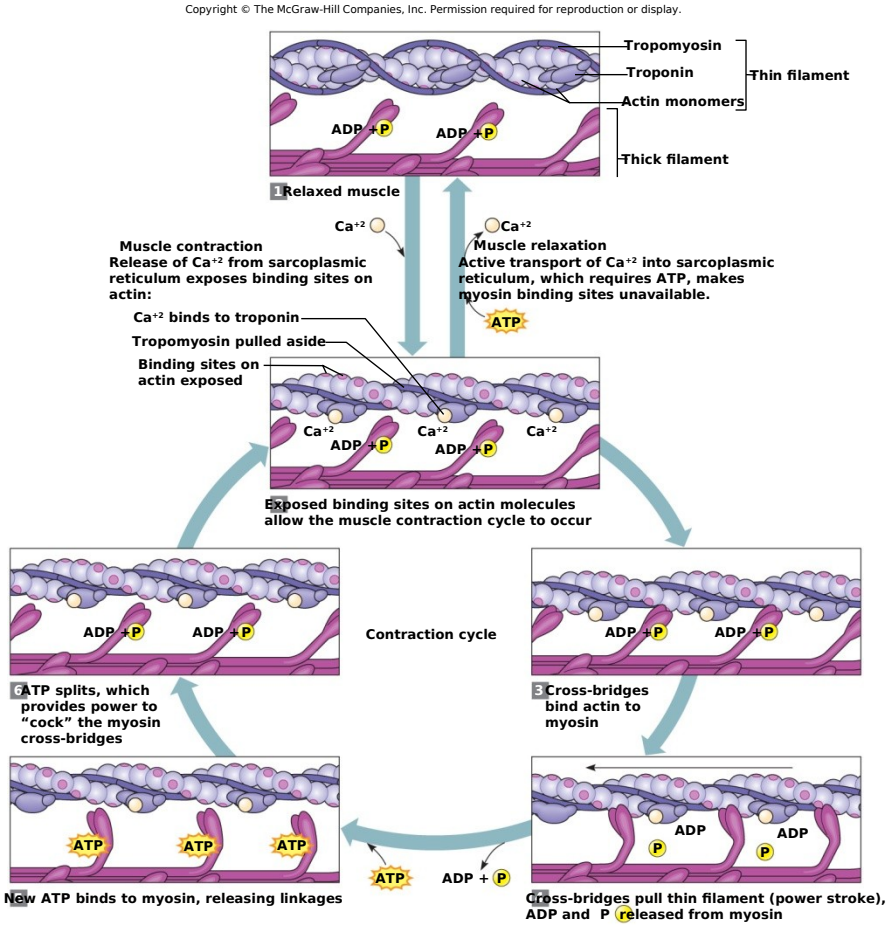


Excitation-Contraction Coupling

- Muscle impulses cause SR to release calcium ions into cytosol
- Calcium binds to troponin to change its shape
- The position of tropomyosin is altered
- Binding sites on actin are now exposed
- Actin and myosin molecules bind via myosin cross-bridges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Tropomyosin
Troponin
Actin monomers
Thin filament
Thick filament
ADP +P
1 Relaxed muscle
Ca+2
Muscle contraction
Release of Ca+2 from sarcoplasmic reticulum exposes binding sites on actin:
Ca+2 binds to troponin
Tropomyosin pulled aside
Binding sites on actin exposed
Muscle relaxation
Active transport of Ca+2 into sarcoplasmic reticulum, which requires ATP, makes myosin binding sites unavailable.
ATP
2 Exposed binding sites on actin molecules allow the muscle contraction cycle to occur
3 Cross-bridges bind actin to myosin
4 Cross-bridges pull thin filament (power stroke), ADP and P released from myosin
5 New ATP binds to myosin, releasing linkages
6 ATP splits, which provides power to "cock" the myosin cross-bridges
Contraction cycle